

Transient Defects in Si at Low Temperature

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Beamline(s): X16A

Introduction: We studied the diffuse X-ray scattering (DXS) from transient defects created by the irradiation of Si(111) by 2 MeV Ar ions at low temperatures. By performing this experiment in the UHV chamber at X16A, we gain the ability to anneal the Si after our measurement has been made to acquire a measure of the thermal diffuse scattering (TDS) background signal.

Methods and Materials: All samples came from the same Si(111) wafer and were irradiated at temperatures from 80K to 300K. Each sample was identically dosed with 2 MeV Ar at the Center for Microanalysis of Materials at the University of Illinois. The measurement procedure for each sample consisted of three stages. First, the sample was placed in the UHV chamber and the DXS was measured scanning radially around a (-111) Bragg peak. Second, the sample was annealed at 650°C for several minutes. Finally, the TDS was measured to provide a background for the sample.

Results: Figure 1 shows the raw intensity data collected for samples irradiated at temperatures between 83K and 232K. To obtain figure 2, we plot $I \Delta q^2$ and subtract the measured background. It is necessary to scale our intensities by a factor of Δq^2 to remove the Δq^2 dependence in the intensity due to the ideal Huang scattering mechanism. The deviations from ideal behavior were then visible as peaks due to vacancies, on the low- q side, or to interstitials, on the high- q side. To summarize the current experiment, figure 2 shows the height of the excess scattering plotted against implantation temperature. More scattering occurs at lower temperature because of the transient defects that are created.

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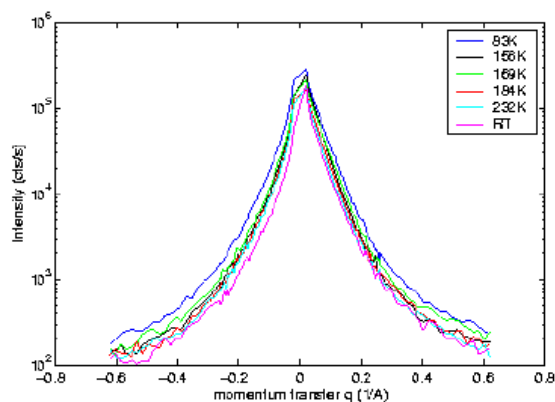


Figure 1. Raw intensity data from the (-111) peak for various temperatures.

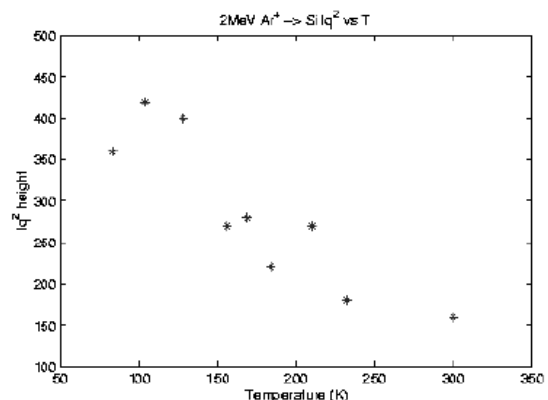


Figure 2. Excess scattering after correcting for background and Huang scattering against implantation temperature.